# Air pollution control, carbon emission futures trading and constructed mangrove sinks for carbon dioxide fixation

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ABSTRACT. Historically, air pollution control was primarily concerned with smoke (ultra-fine particulate), aerosol (mist) and odour elimination. Less immediately obvious air pollutants such as potentially noxious, but invisible gases and vapours, were disregarded until more recent times when more sensitive analytical techniques became available. Even more recently, ever increasing volumetric emissions of gaseous combustion products and their atmospheric accumulation that are responsible for stratospheric ozone depletion and/or are effective greenhouse gases exhibiting significant global warming potential are issues that have gained international political prominence and have resulted in the Montreal Protocol, as far as anthropogenic compound release on the ozone layer is concerned, and the Kyoto Protocol, as far as primarily carbon emissions on global warming are concerned. For global pollution control measures to be effective, stringent and enforceable legislation coupled with severe financial penalties in default have been established, but the transfrontier nature of global air pollution has allowed the concept of emissions trading between over-producers and under-producers, particularly those offering significant sink capacity, by a commodity type market, based primarily on carbon dioxide, in emission futures.

Waste gas biotreatment has provided an important and effective pollution control technology as far as the elimination of a relatively narrow range of individual gaseous and volatile compounds and simple mixtures thereof are concerned, but in spite of being the successor technology to an entire spectrum of processes involving gaseous and volatile liquid feedstocks (substrates) and products, it has very largely failed to impact on the control of greenhouse gas emissions. The critical criteria in all processes, both engineered and natural, involving gaseous substrates are substrate conversion and the conversion coefficients that either pertain or can be achieved by process manipulation. Much of the research concerning waste gas biotreatment has failed to understand the important process mediating biochemical mechanisms involved, particularly the roles of both individual microbial consortia and inter-consortia relationships, particularly as far as the elemental cycles are concerned, but also the fact that few such cycles function in isolation. Although carbon dioxide emissions currently dominate the discussion of global greenhouse gas effects, it is important to consider other gases, particularly methane and nitrous oxide, that exhibit mass warming potentials compared with carbon dioxide of 20 x and 200 x, respectively, as well as exhibiting significant atmospheric lifetimes. Methane, is of course, the primary product of natural anaerobic digestion by methanogenic consortia and its release to atmosphere depends on the performance of methanotrophic consortia, while nitrous oxide is an intermediate product of the denitrification process and results from excessive application of fertilizers during intensive agriculture. Essentially, humans have developed into successful geochemical

manipulators with anthropogenic impacts of magnitudes approaching those of the natural biogeochemical (elemental) cycles. Reservoir construction, land drainage and reclamation, dredging, ocean dumping and, most recently, artificial mangrove planting in tropical and sub-tropical coastal marine environments, are all activities of a scale that can seriously impact the environment in that the natural balance is no longer in equilibrium. The carbon and nitrogen cycles are inevitably affected, while in the case of marine situations, sulphur cycle problems also occur.

The primary purpose of establishing artificial mangrove plantations is as a greenhouse gas sink with obvious financial gain from emission trading rights. However, both microbially mediate activity in mangrove root zones (sediments) as far as greenhouse gas emissions and volatile organic carbon emissions from foliage are concerned, little or no evaluation has been carried out. When such environmental impact studies are executed, such approaches may prove to be none sustainable. Perhaps the problem will then be solved with biotreatment systems employing methanotrophic consortia for methane and nitrous oxide elimination and hydrogen bacteria or other chemoautotrophic bacteria for carbon dioxide removal. The excess biomass produced could be used as a protein rich animal feed or as it was better known, 30 years ago, as single cell protein (SCP).